Analysis of SPATIAL AGGLOMERATION of KIS and HT-manufacturing in the Metropolitan Region of Barcelona (MRB)

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EUROPEAN UNION

The Case for Agglomeration Economies in Europe (CAEE)
ESPON - European Spatial Planning Observation Network
Barcelona City-Region Case Study

UNIVERSITAT POLITÈCNICA DE CATALUNYA
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This presentation

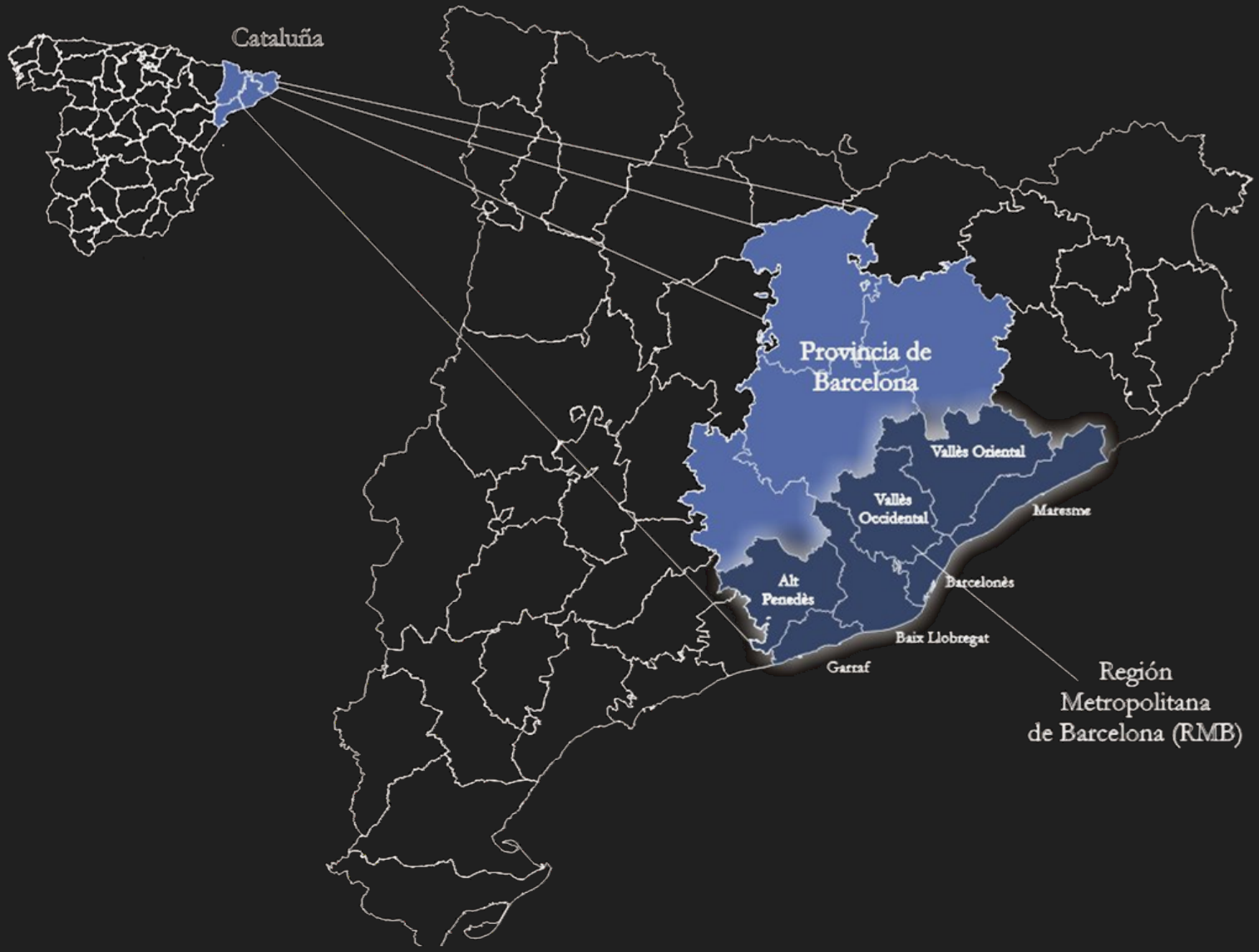
- Economical development and 'performance' of the Barcelona city region. It shows results of the CAEE study *(The Case for Agglomeration Economies in Europe)* of the ESPON program.

  Main purpose of CAEE was to examine the relationship between agglomeration economies and city-regional/metropolitan governance.

- Progress in defining functional economic areas of KIS and HTI sectors in MRB.

  With the assistance of a spatial interaction model, we constructed functional economic areas in which MRB is structured from the perspective of the complementarity of economic activity.

Study area and overview



Portrait of the Barcelona city region (I)

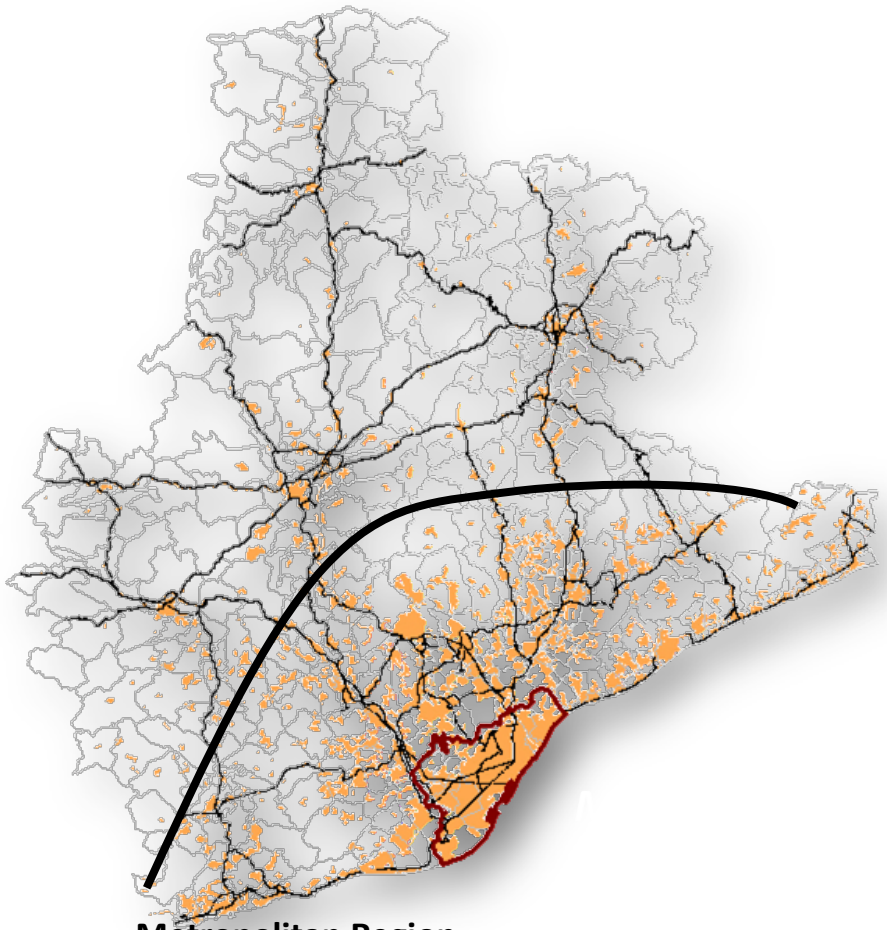
Barcelona Province

In 2001 the population was 4.805 million of inhabitants (Census), distributed throughout a total of 311 municipalities and 11 counties, in an area of 7,728 km2.

Over 50% of the population of the city-region lies within 7 municipalities with populations in excess of 100,000 inhabitants. It is concentrated within 3.5% of the total area of the city region,

By contrast just over 20% of the population resides in 161 municipalities of less than 20,000 inhabitants, distributed over more than 87% of the city region.

The remaining 29% of the population of the city region lies within 37 towns and cities in the 20,000 - 100,000 range, spread over just 9.5% of the total area.



Metropolitan Region of Barcelona (MRB)

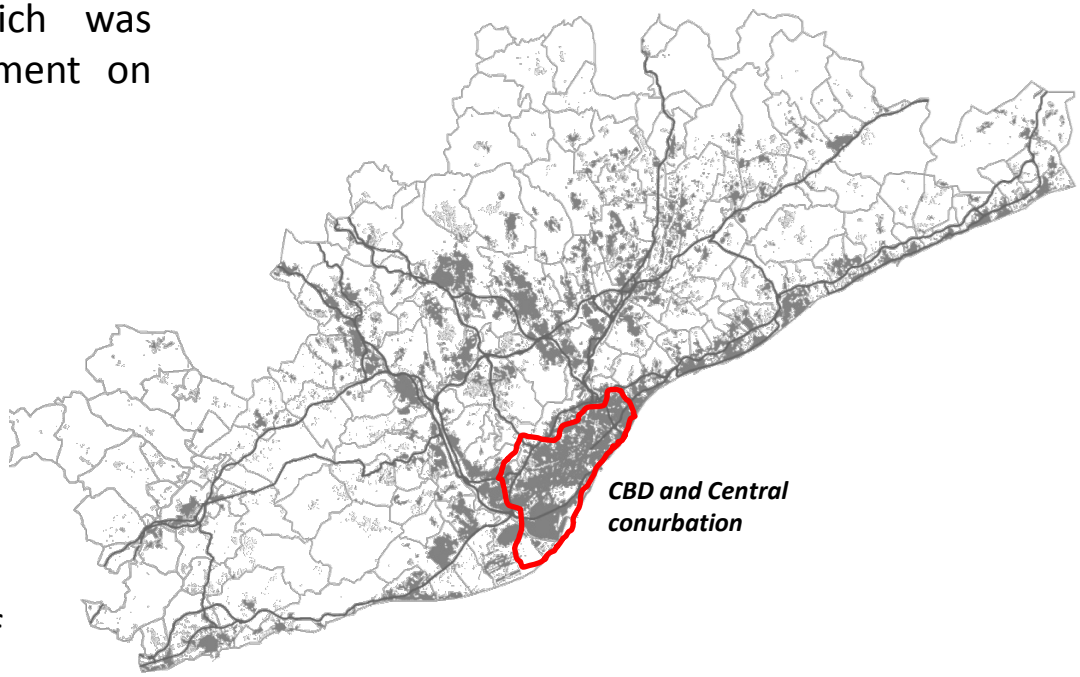
Portrait of the Barcelona city region (II)

Metropolitan Region of Barcelona (MRB)

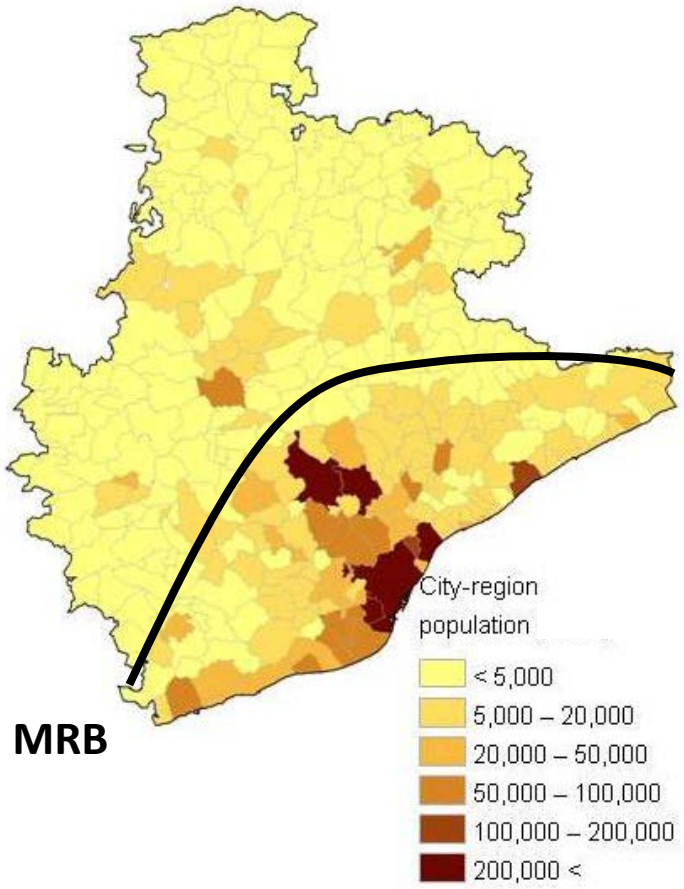
The MRB comprises 164 municipalities, being considered as the commuting area of Barcelona. Territory corresponds to the Metropolitan Territorial Plan, which was approved by the Regional Government on 2010.

Figures from 2001 Census (MRB)

- 4.390 million inhabitants
- 1.963 million locally based jobs (LBJ)
- 1.951 million resident workers
- 75% of Catalan GDP and 13% of Spanish GDP



Portrait of the Barcelona city region (III)



Spatial distribution of locally-based jobs within the Barcelona city region (2001)

% Population of city region (Province), surface, density and political fragmentation

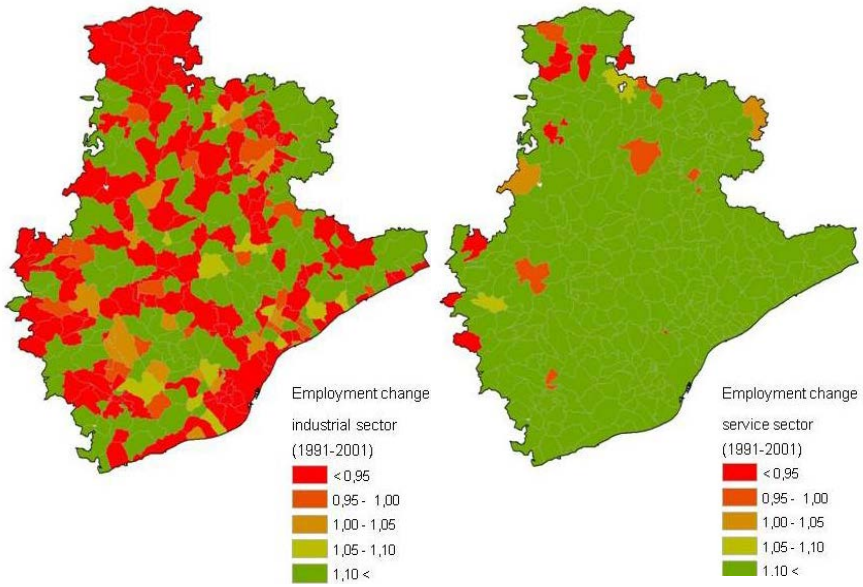
Territorial unit	% of total population of city-region (Province)	Area (km^2)	Density (inhab./ km^2)	Admin. Units(s)
Barcelona	29.83	101.4	15,935.98	1 mun.
Metropolitan región of Barcelona (RMB)	90.99	3,236	1,523.13	164 mun. 7 counties
Province (Barcelona)	100%	7,728	700.89	311 mun. 11 counties 1 province
Region (Catalonia)	N/A	32,113.39	229.31	947 mun. 41 counties 4 provinces

Employment and change during the period of 1991-2001

- 8.5% increase in the economically active resident population (RP)
  2.140 million RP in 2001.
- 16.9% increase in the locally-based jobs (LBJ)
  2.025 million LBJ in 2001.
- Manufacturing sectors decrease 17 % in the LBJ to 551,689 in 2001,
- Service sector increase 29% in the LBJ to 1.292 million LBJ in 2001.

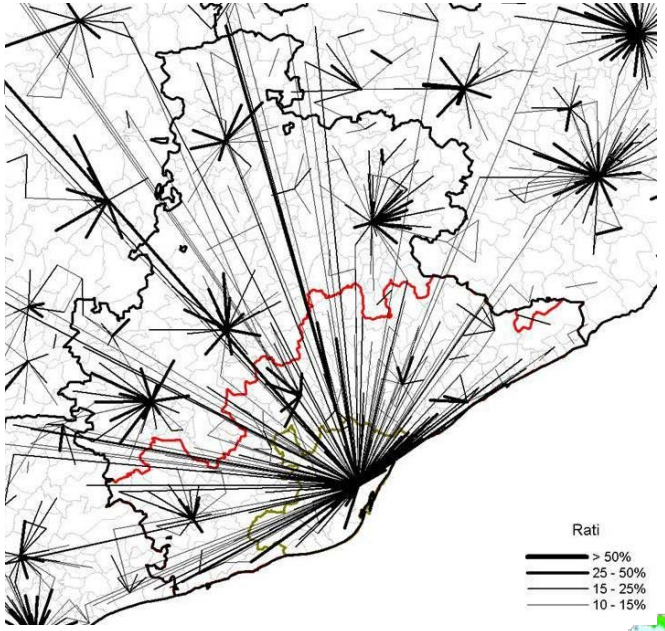
	Agriculture	Industry	Construction	Services	TOTAL
Economically active resident population 1991	30.400	775.680	177.463	990.486	1.974.029
(% of total)	1,54	39,29	8,99	50,18	100
Economically active resident population2001	21.403	569.300	198.368	1350.834	2.139.905
(% of total)	1,00	26,60	9,27	63,13	100
Locally-based jobs 1991	22.614	663.590	126.342	919.547	1.732.093
(% of total)	1,31	38,31	7,29	53,09	100
Locally-based jobs 2001	19.868	551.689	161.444	1.291.641	2.024.642
(% of total)	0,98	27,25	7,97	63,80	100

Change in LBJ (1991-2001) in the industrial and service sectors



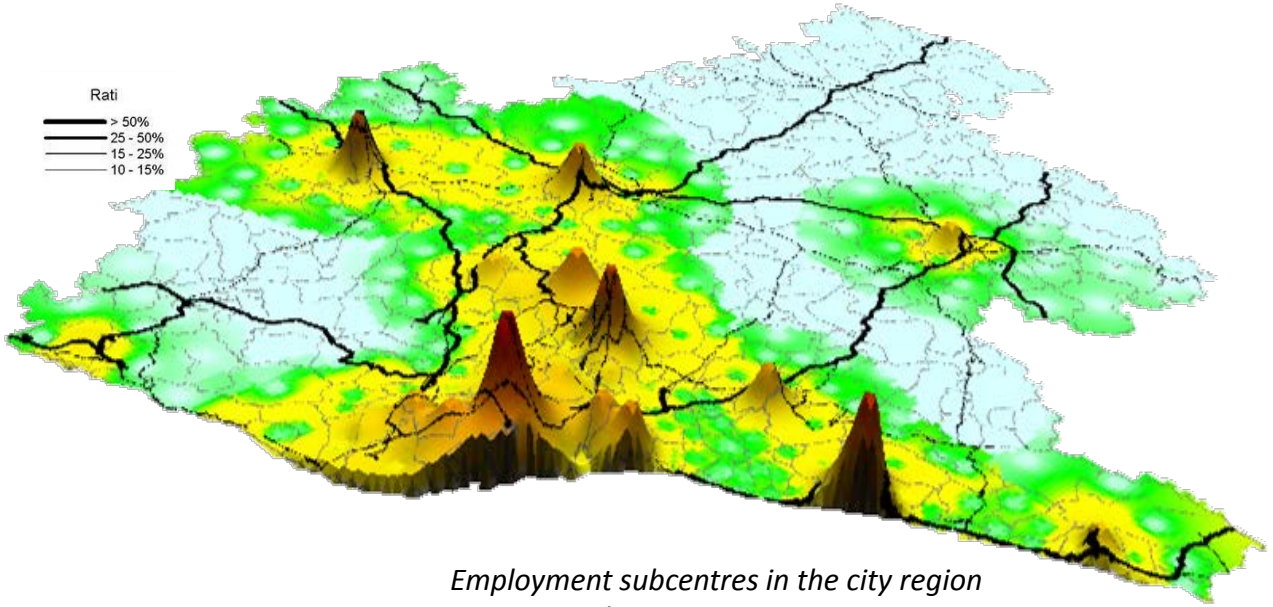
Employment density and commuting flows (2001)

Consolidated subcentres of employment



Travel to work flows between municipalities of Catalonia

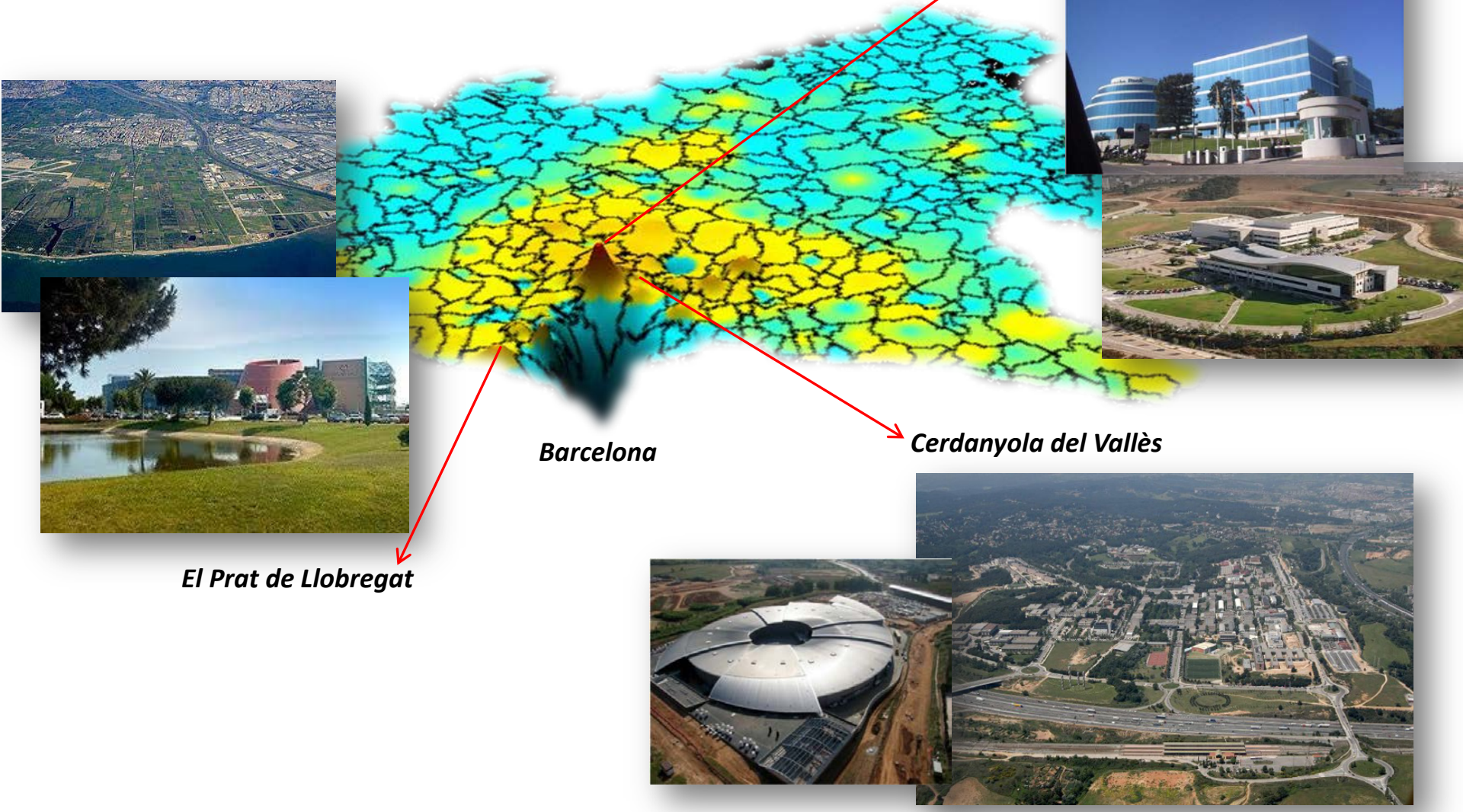
- 50% of the locally-based jobs were contained within 5 municipalities (Barcelona, Sabadell, Terrassa, L'Hospitalet de Llobregat and Badalona).
- 28% of the locally-based jobs of the city region were contained in some 28 municipalities.



Employment subcentres in the city region
Density analysis 2001

Decentralization of employment (1991-2001)

Emergent subcentres



What role key sectors have?

The city region is changing into a service-based economy, where knowledge is set to have a central role. This structural change is clearly visible in the city of Barcelona, where knowledge-based industries are replacing the old industrial sites, which in turn, are moving to the wider metropolitan region.

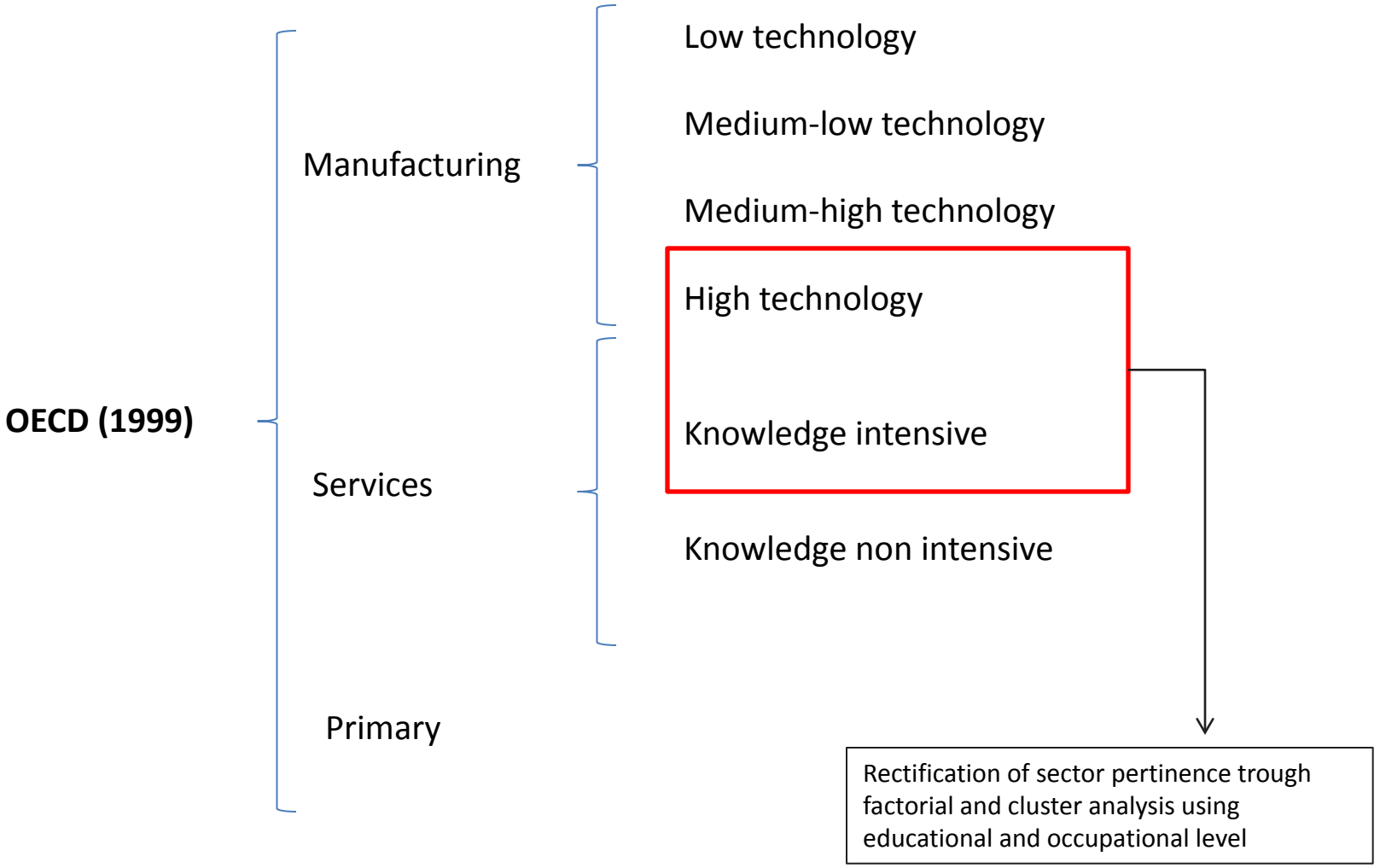
Labour market of Key Sectors

In order to reach an understanding of the effects agglomeration economies exert over the territory, economic sectors linked to "knowledge economies" (areas defined by the OECD as high-tech industries, medium and high technology industries, high knowledge activities) have been selected. Textile and clothing industries were also selected on the basis of the strong historic tradition within Catalonia and their importance within the economic base of the city region.

The analysis was carried out in 2001, based in 2001 Census data, and in a complementary form for 1991. The objective was, in the first place, through a dynamic analysis to identify the details of the process of evolution of the localization of the selected economic activities; and in the second place, to gather criteria for the selection of a number of municipalities of the study area which represent processes of growth in these economic sectors.

This enabled a qualitative analysis (through interviews) to be carried out, to determine the degree to which governance processes had facilitated, or not, this process.

Sector selection



Selected Key Sectors (5 groups)

1)Creative industries (e.g. media, culture, sportive)

2) Financial and business related services (e.g. bank, insurance, finance, professional services)

3) Medium-high technological industries (e.g. hardware, precision machinery and medical instruments, advanced electronics)

4) Education and Research and Development; and

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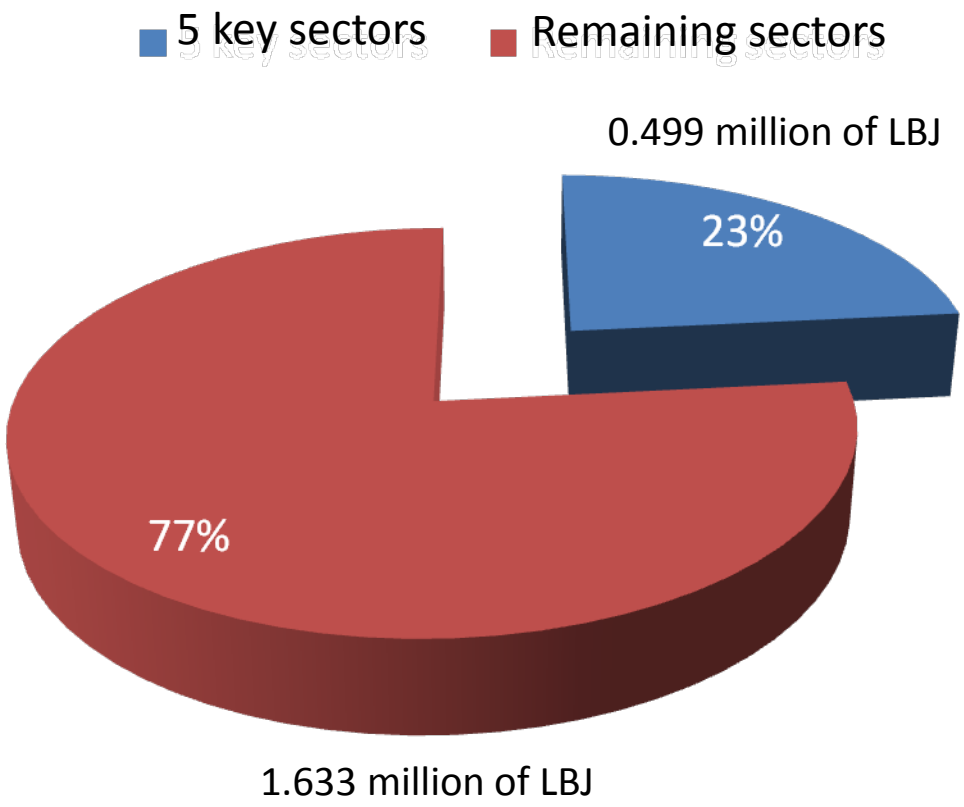
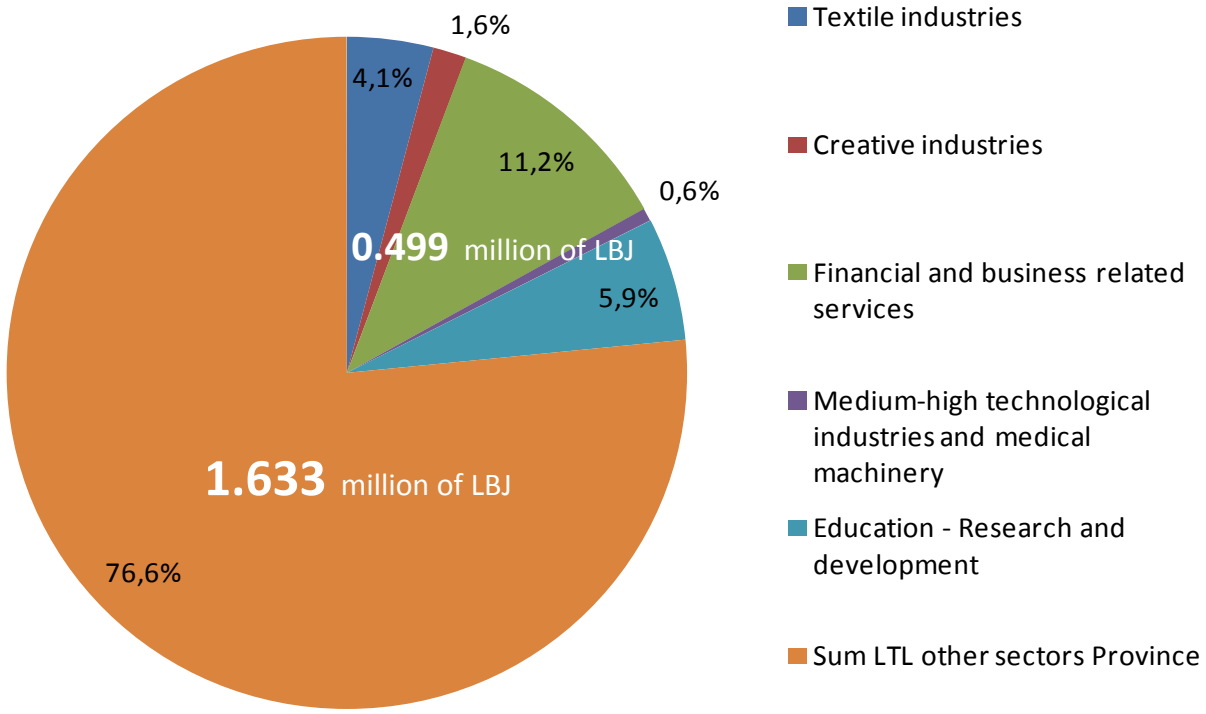
5) Textile related activities (because of their importance in the city region (CAEE-ESPON)

Share of the key sectors on provincial labor market, 2001



Source: 2001 National Census

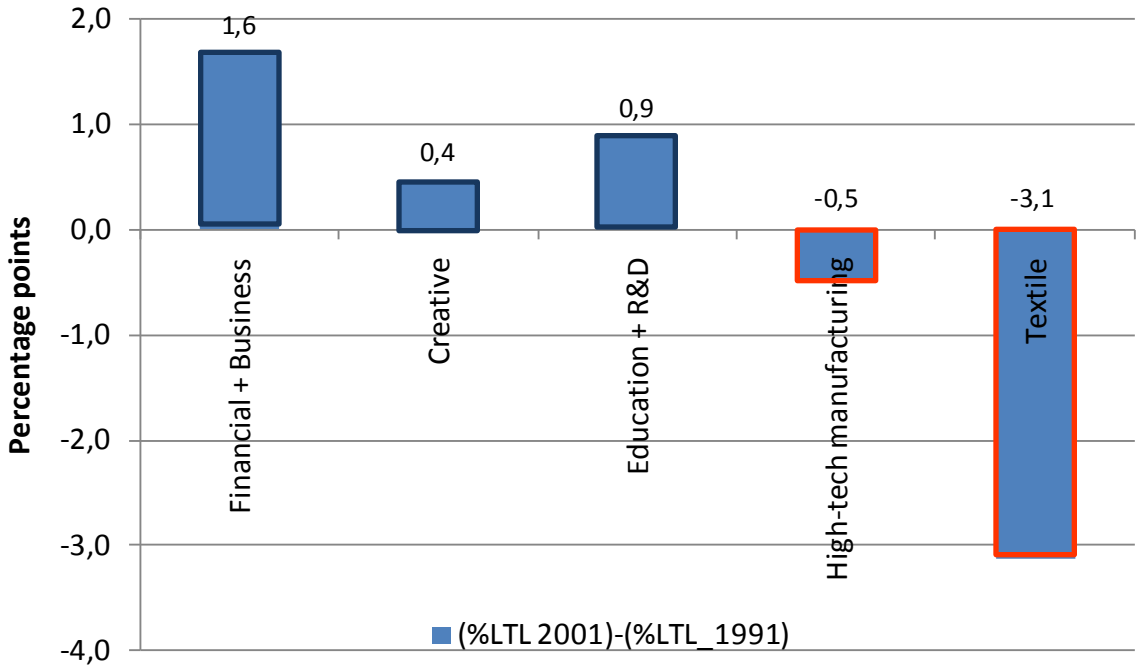
Share of the key sectors on provincial labor market, 2001 (II)



Source: 2001 National Census

Structural change 1991-2001

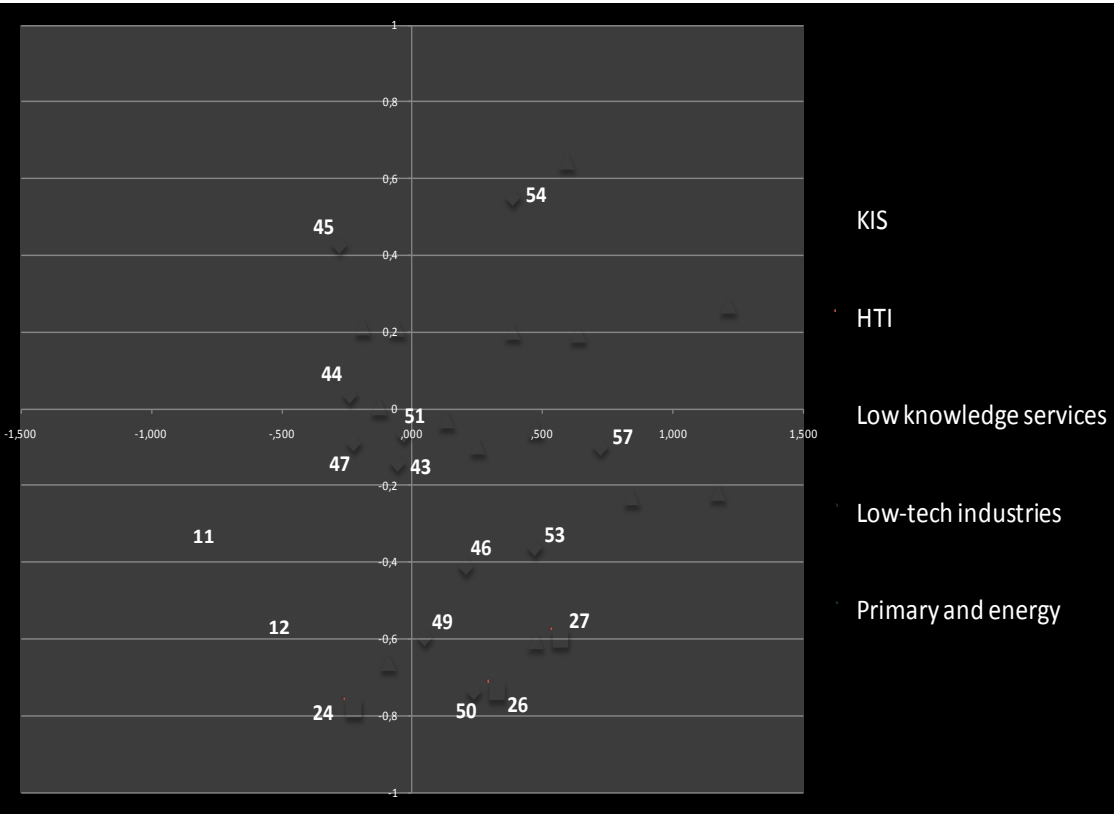
5 sector's share 1991-2001



What is the role of the Key sectors in the structural hierarchy of economical relationship?

Multidimensional scalling analysis of economical relationship

Proxcal analysis from Matrix input-output Catalonia, 2001



Financial and business

45 Insurance and pension plans
47 Real estate
44 Financial services
46 Auxiliary services to financial services
49 Computer services
51 Other business Services
64 Postal and Telecommunications

HT-manufacturing

24 Office machinery and computers manufacturing
26 Manufacture of electronic materials, radio, tv and communications
27 Manufacture of surgical instruments, precision optics and watches

Education

50 Research and Development
53 Education services

Creative

57 Recreational, cultural and sport

Textile

11 Industries clothing and fur
12 Textile

Average distance to the Key sectors from other economic sectors

Proxcal space of economical dependency matrix

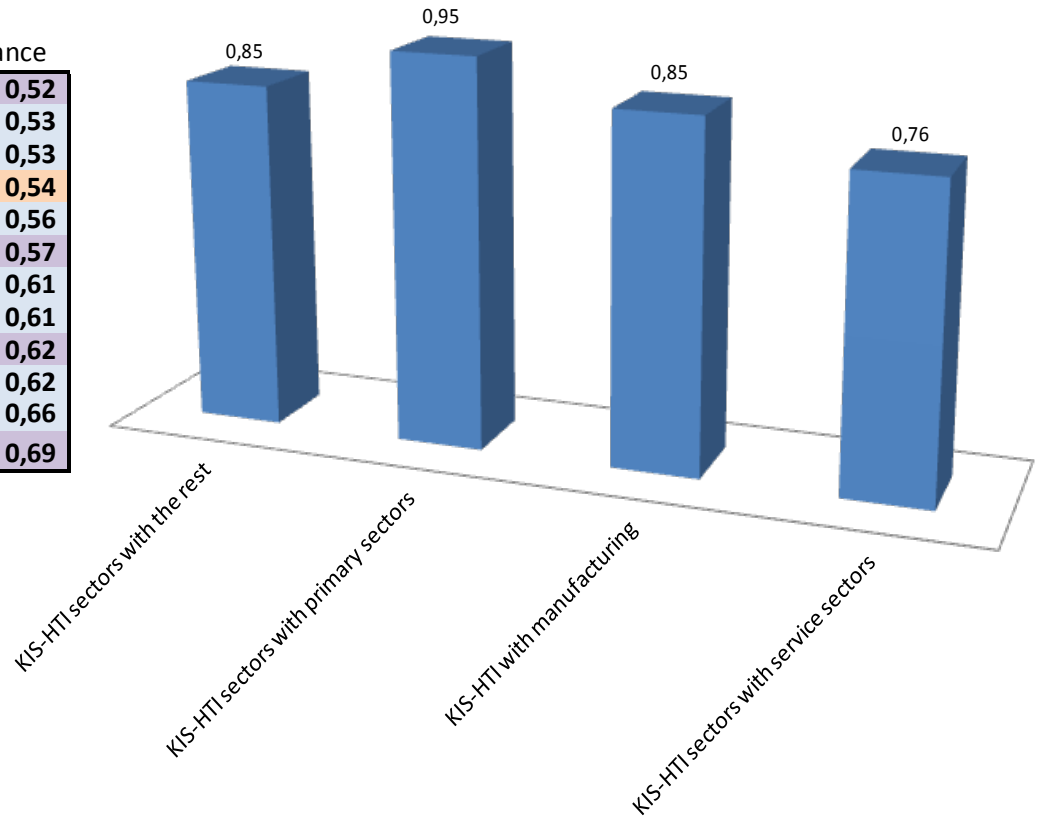
Quartile (Q) 1: **0,60** Q 2: **0,75** Q 3: **0,95** Q 4: **1,18**

sector code	sector name	distance
s30	Furniture and other manufacturing	**0,52**
s42	Services related to transport and services of trav	**0,53**
s48	Rental services of machinery	**0,53**
s33	Distribution of water and other services related	**0,54**
s36	Services and wholesale trade intermediaries	**0,56**
s25	Machinery and electrical materials	**0,57**
s40	Maritime transport services and by roads	**0,61**
s41	Air and space transport services	**0,61**
s16	Products of the edition, printed and recorded ma	**0,62**
s37	Retail services (except motor vehicles) and repa	**0,62**
s35	Services trade and repair of motor vehicles	**0,66**
s34	Construction	**0,69**

Manufacturing

Services

Primary-energy



So…What role the key sectors have in the planning of territory?

Identification of Key sectors' subcentres

Cut-off criteria used by García-López (2007) in the MRB *(based on density cut-offs (density and mass) developed by Giuliano & Small in Los Angeles 1991)*

A municipality is proposed as a subcentre if it:

1. Has a density of metropolitan Locally based jobs LBJ/Km2 > Metropolitan density average

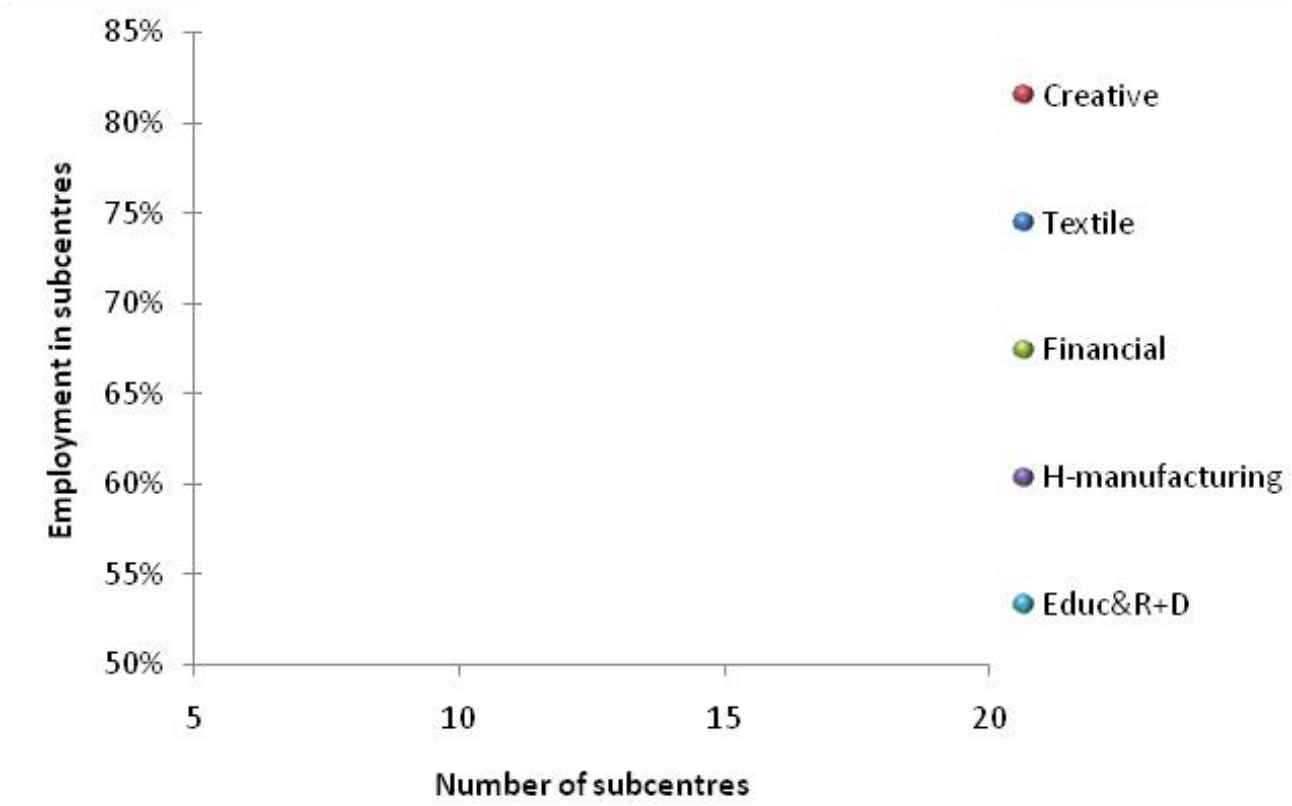
1. Concentrates >1% of LBJ of whole metropolitan region

Subcentres of concentrated employment by sector (2001)

Employment sub-centres	Textile industries	Creative industries	Financial and business related services	Medium-high technological industries and medical machinery	Education, research and development
No. of municipalities	13	11	11	18	15
Total locally-based jobs per sector	49,885	25,651	181,907	9,011	89,937
Locally-based jobs per sector/Locally-based jobs per sector in the city-region	57.1%	76.0%	76.1%	67.9%	71.4%

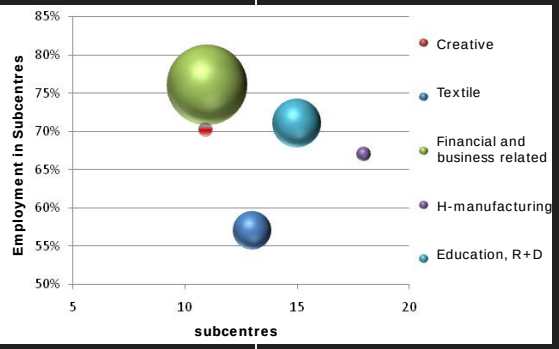
Table 16: Locally-based employment sub-centres of the key sectors (2001)
Source: INE, Census of Population, 2001

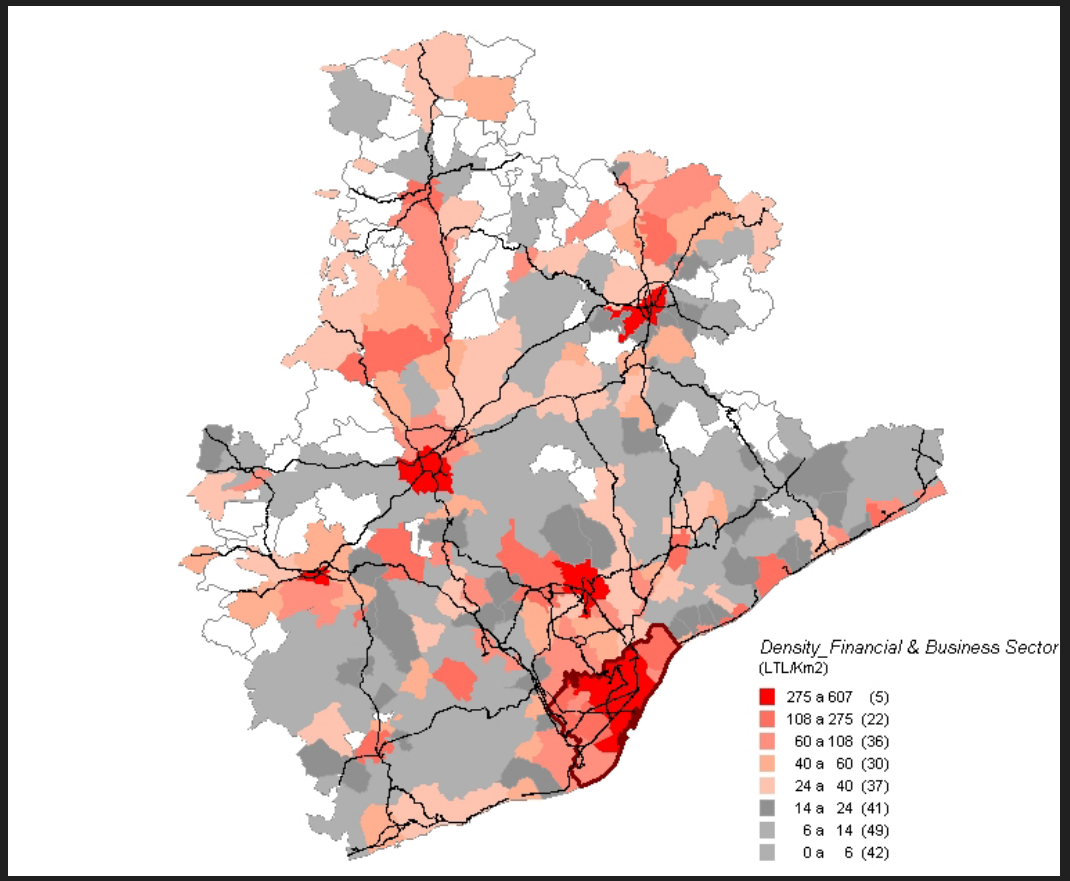
Subcentres for the 5 key sectors, 2001



Size of the mark denotes average size, in employment terms, of Key sectors

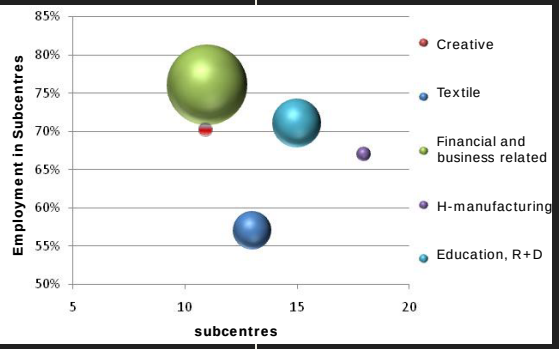
Subcentre for the 5 key sectors 2001: Financial

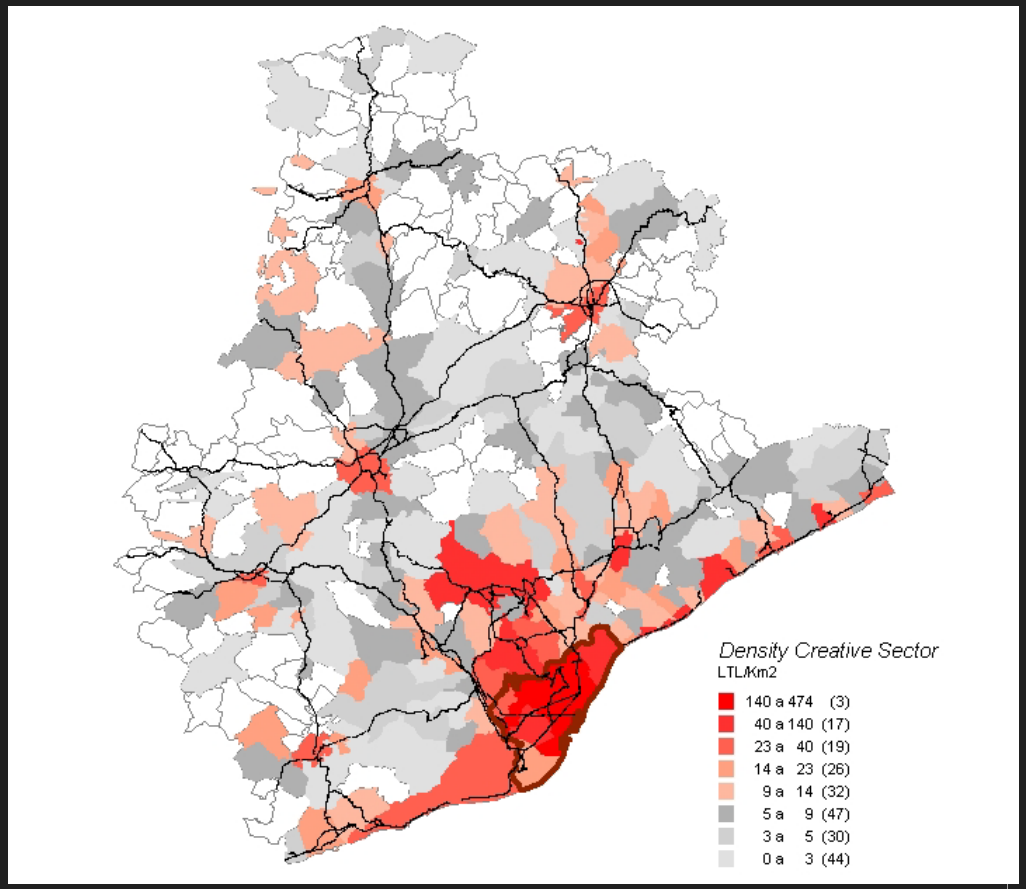




11 subcentres

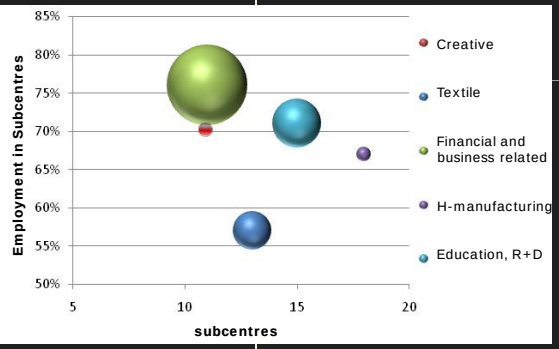
Subcentre for the 5 key sectors 2001: Creative

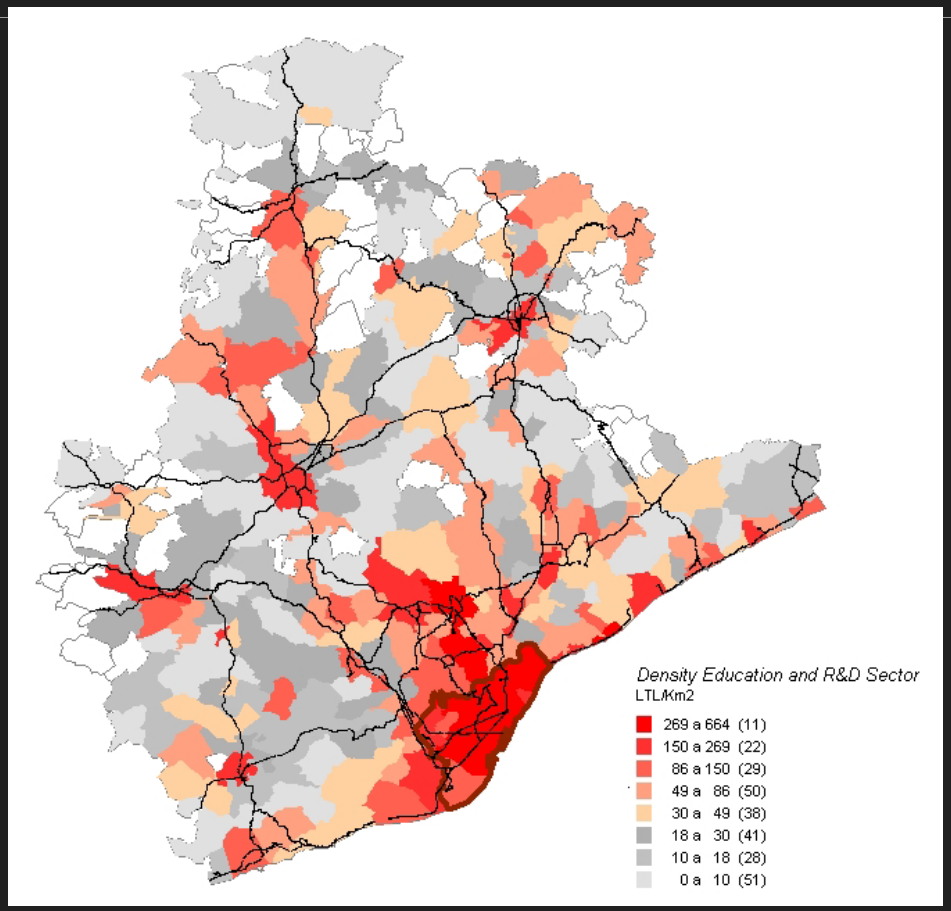




11 subcentres

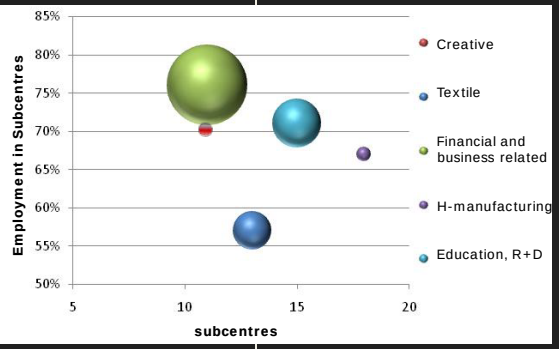
Subcentre for the 5 key sectors 2001: Education + R&D

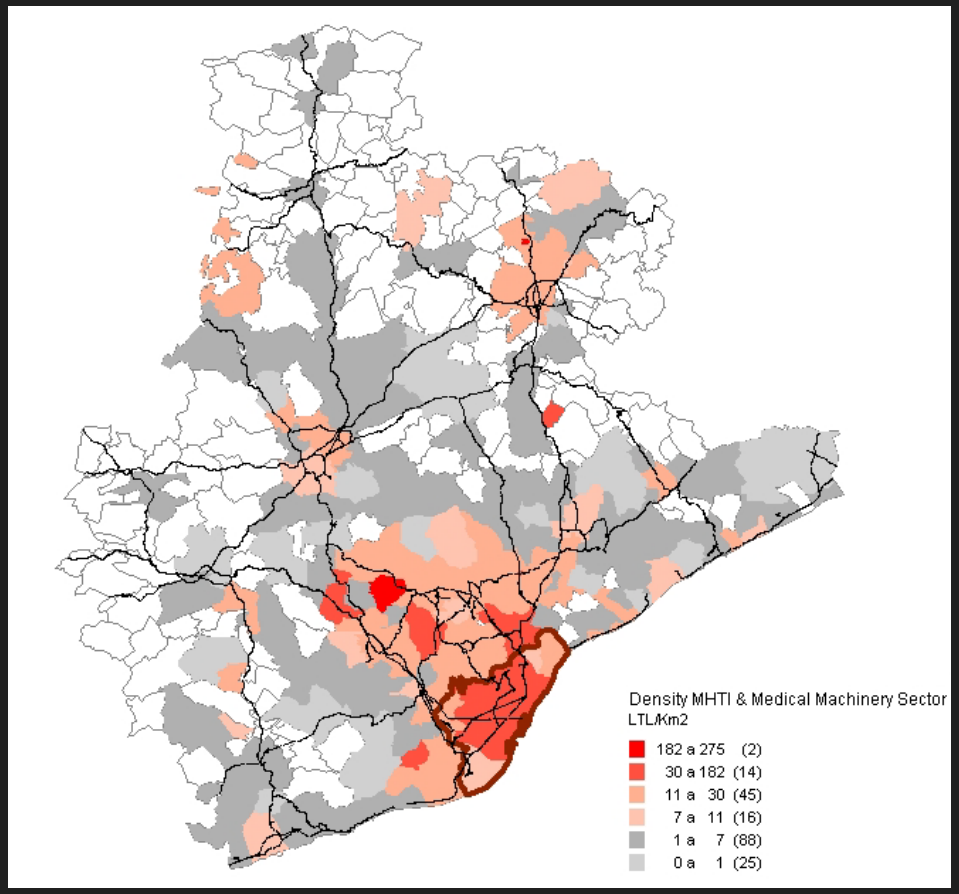




15 subcentres

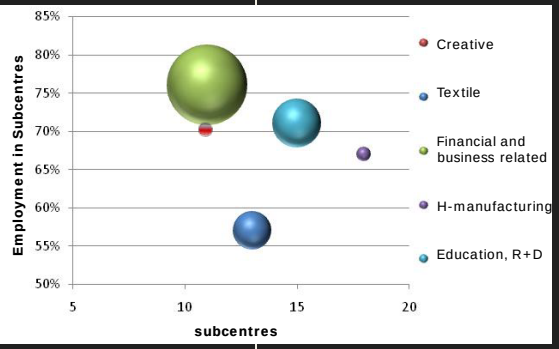
Subcentre for the 5 key sectors 2001: High-tech Manufacturing

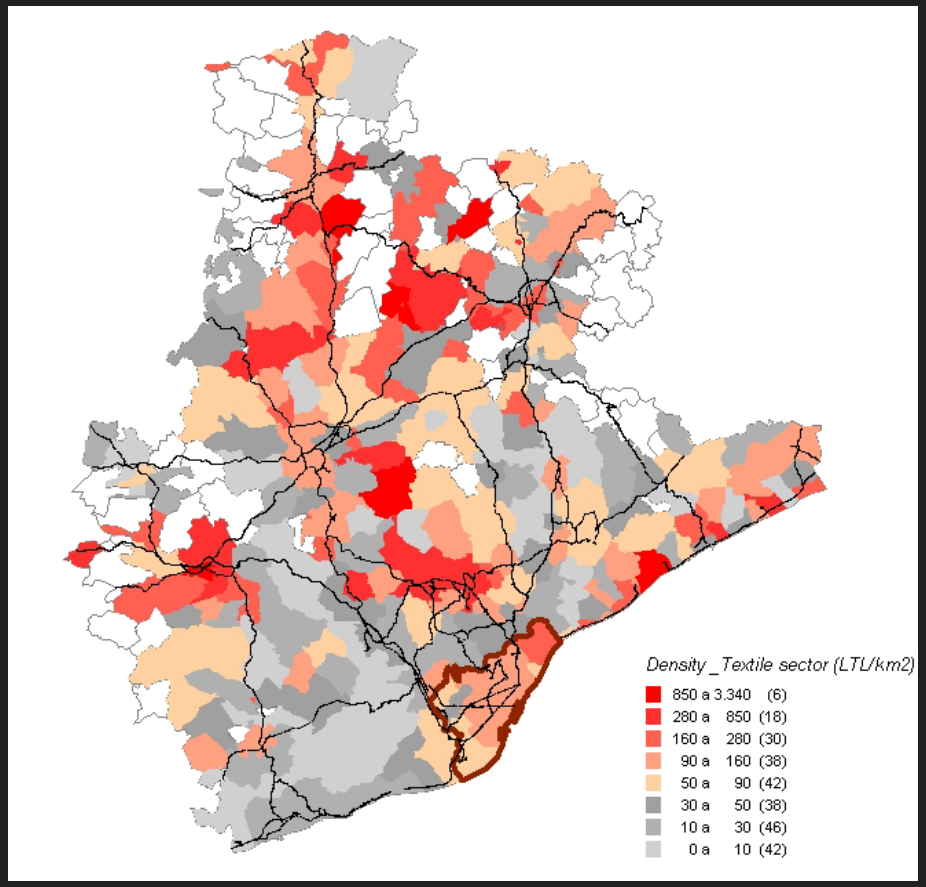




18 subcentres

Subcentre for the 5 key sectors 2001: Textile

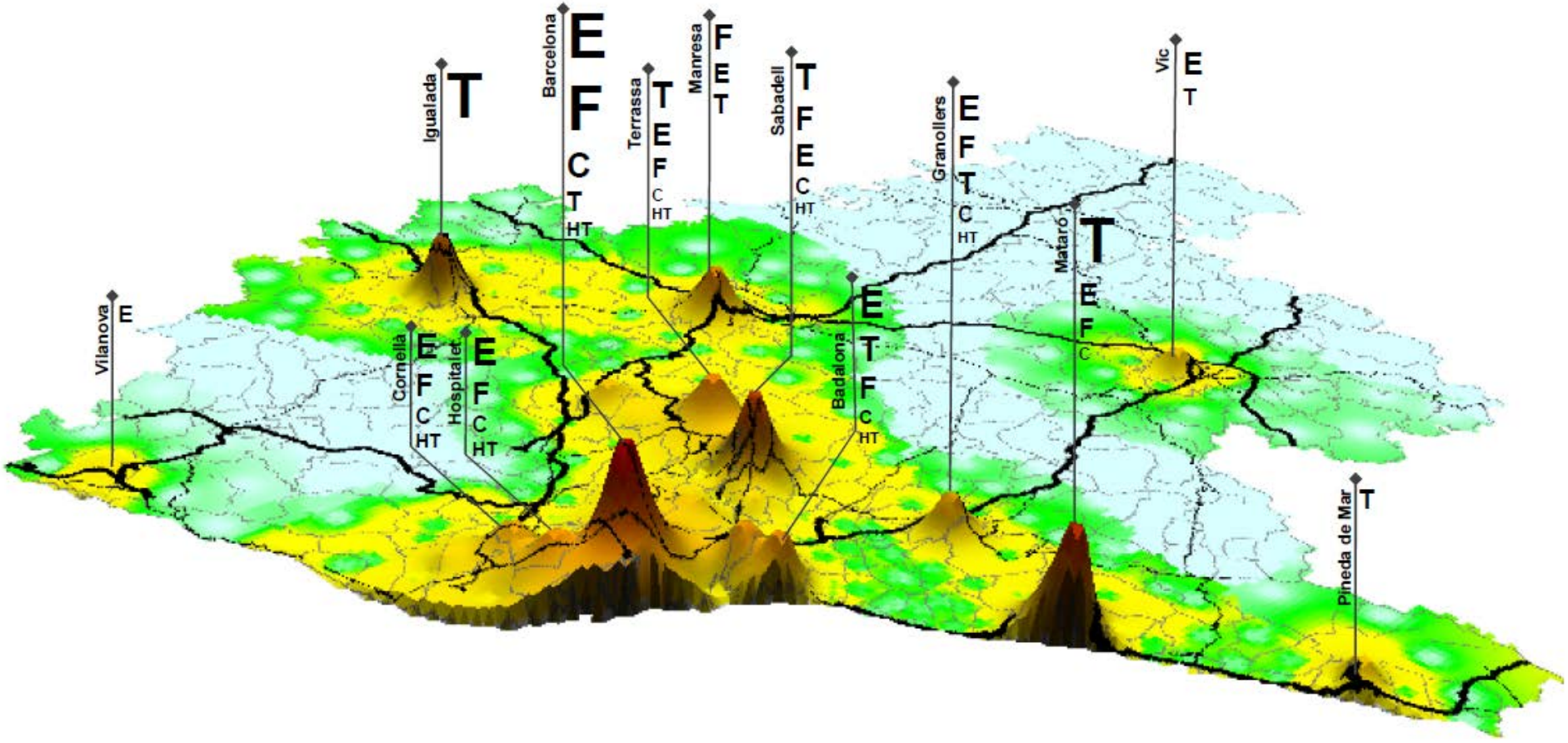




15 subcentres

Subcentre for the 5 key sectors 2001: comparison

Barcelona Province



E= Education+ R&D

F= Financial + Business

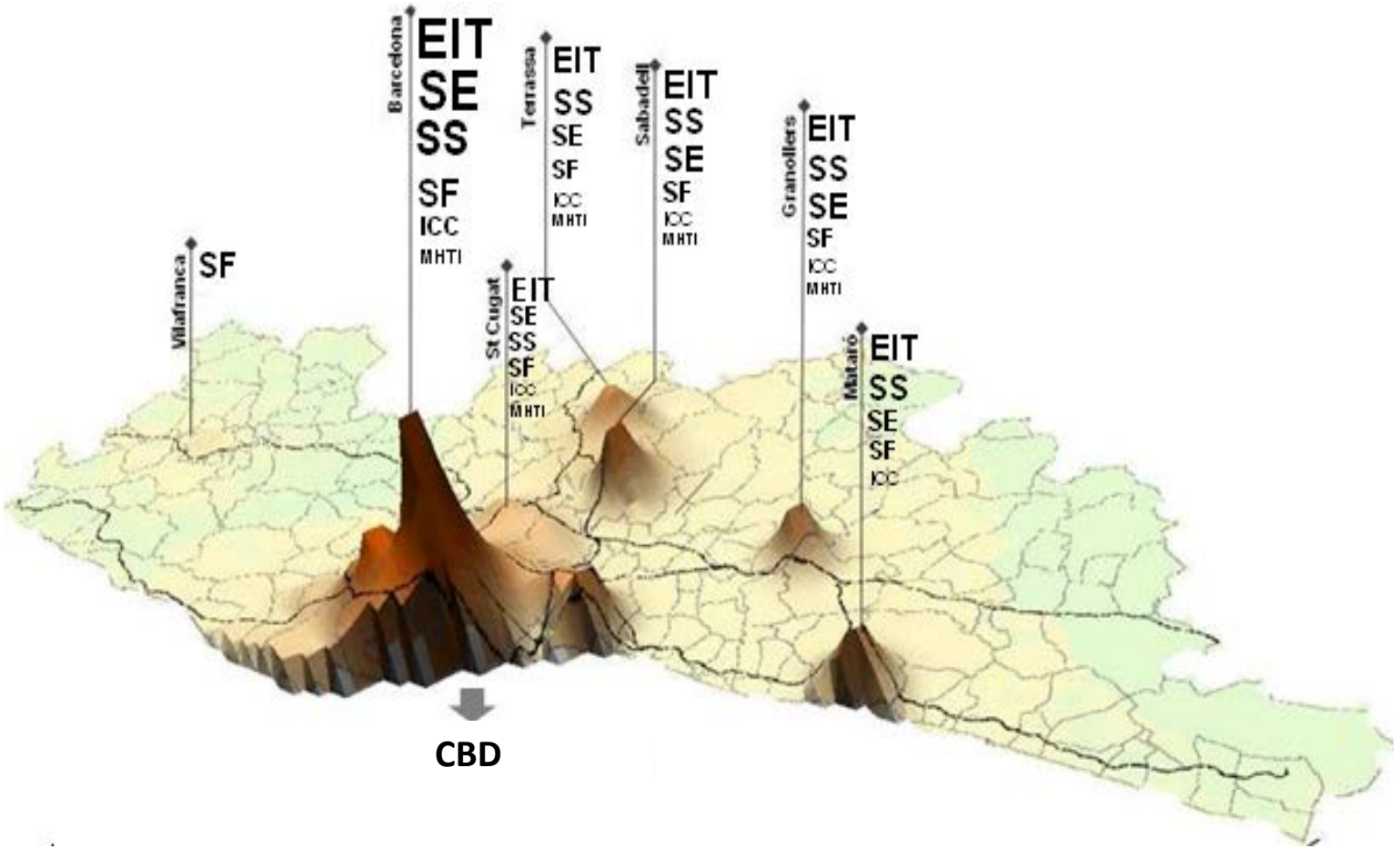
C= Creative

T= Textile (conventional)

HT= HT Manufacturing

Subcentre for the 5 key sectors 2001: comparison (II)

MRB (only KIS-HTI sectors) -without textile



EIT: education, software services, telecommunications **SE:** Related business services **SS:** Healty services **SF:** Financial services
ICC: cultural industries **MHTI:** Medium-high technology industries

Subcentre for the 5 key sectors 2001: comparison (III)

Location patterns Key sectors

MRB (only KIS-HTI sectors) -without textile

Area	numbers of municipalities by area	% of LBJ of KIS and HTI sectors	ratio of LBJ of KIS and HTI sectors
CBD and central conurbation	**9**	**64.1%**	**7.1%**
Employment subcentres	**14**	**14.2%**	**1.0%**
Cities connected by highways with employment subcentres	**36**	**7.5%**	**0.2%**
Rest of territory of MRB	**105**	**14.3%**	**0.1%**
All MRB	**164**	**100%**	

Subcentres are consequences of a hierarchical employment organization… so What happen to their areas of influence?

Definition of the functional economic areas of KIS and HTI sectors in the MRB

Functional economic areas of KIS and HTI sectors: characteristics

They have a high level of diversity of the production structure,

They have a relationship of interdependence between different economic sectors found in them,

They comply with maximum self-restraint of production, higher than average self-contained city municipalities and,

They are structured around a center of header (subcentre) to where the main economic flows are.

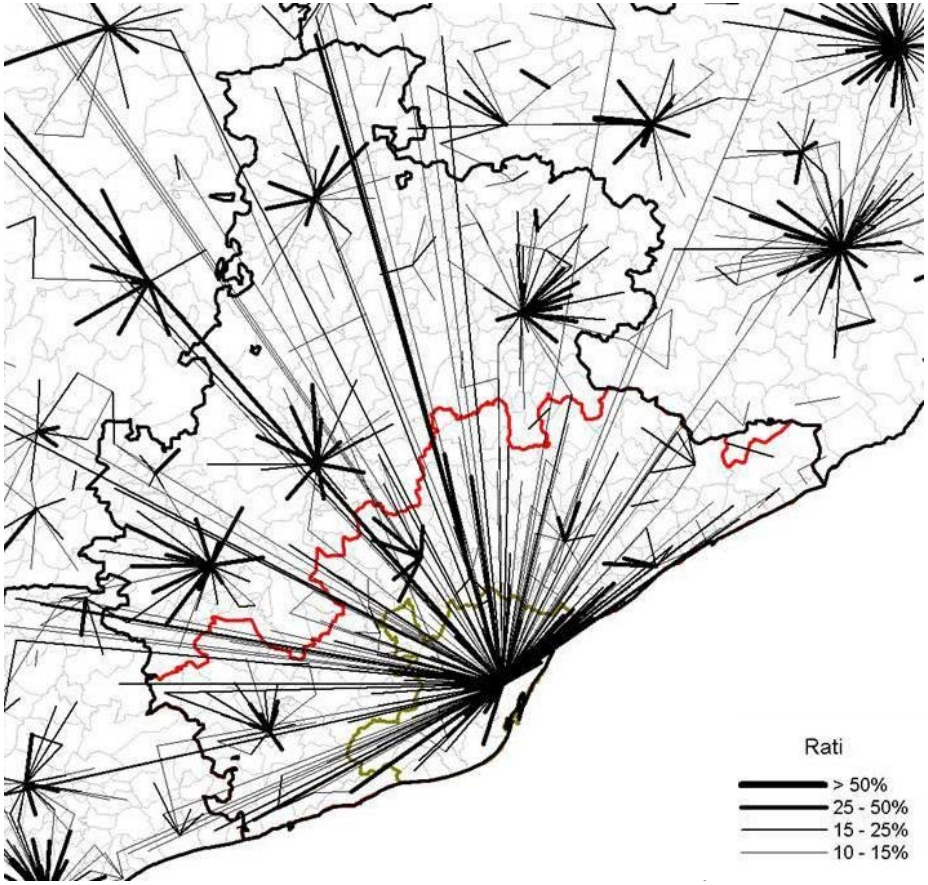
Methodological steps

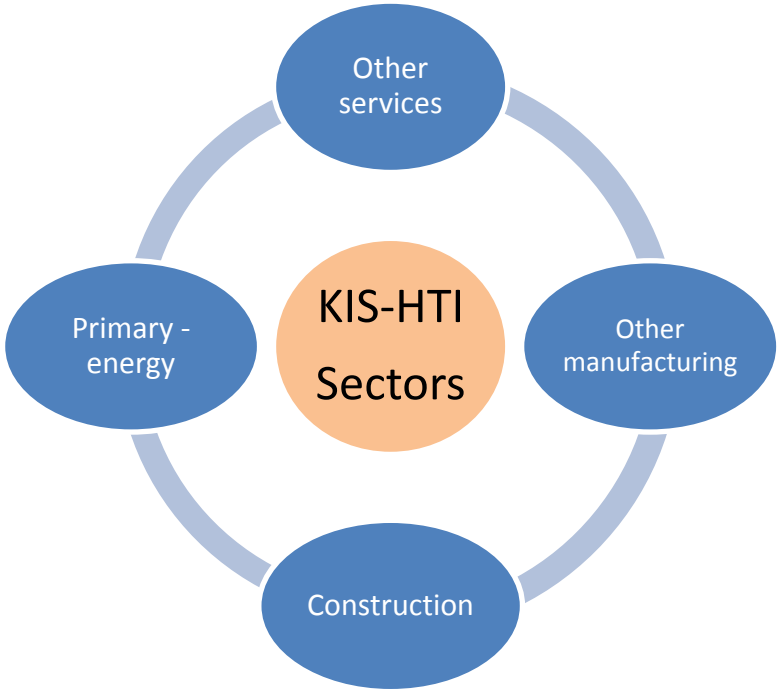
1- From input-output matrix (which accounts for complementarity among economic sectors) and matrix of commuting flows (which accounts for the location of workplaces by economic sector), we estimate the monetary flows among the different municipalities of Catalonia with the assistance of a spatial interaction model.

2-From these flows are constructed functional areas in which territories are structured from the perspective of the complementarity of economic activity. In order to do this, with the maximum interaction value of economical flows, we estimate the functional economic areas, which correspond to areas with high values of self-contention of economical activity.

Step One: Spatial interaction model

Spatial interaction model of economical relationship constrained in origin

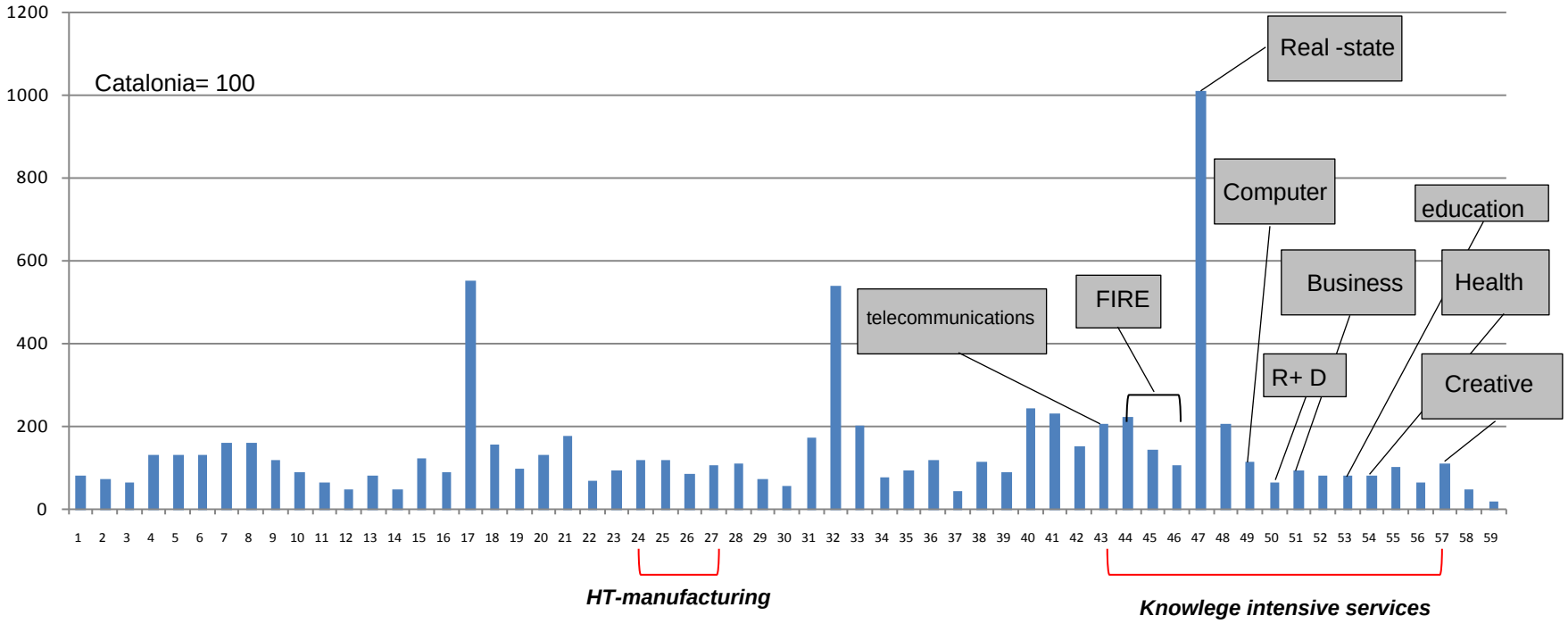




Step One: Modeling the economic flows between municipalities

This estimate is obtained by multiplying the number of LBJ in a particular sector for their respective productivity expressed in EUR / LBJ

Apparent productivity of LBJ by economic sector (from the input-output table of Catalonia, 2001)



Step One: Spatial interaction model

Origin constrained model of economical relationship:

$$Fij_{x-y} = Oi_{x-y} \frac{\frac{Dj_{x-y}}{dij^{\beta}}}{\sum_{j=1}^{946} \frac{Dj_{x-y}}{dij^{\beta}}}$$

Where:

Fij $_{x\text{-}y}$= is the flow that relates *x* production sector in the municipality *i* to the demand of the sector *y* located in municipality *j.*

Oi $_{x\text{-}y}$= is the part of the sector's output *x* located in the municipality *i* would sell the sector *y* located in the 946 municipalities *j* of Catalonia. To estimate this value has increased the sector's total output *x* located in the city *i* by the technical coefficient of input-output matrix that relates the sector *x* to *y.*

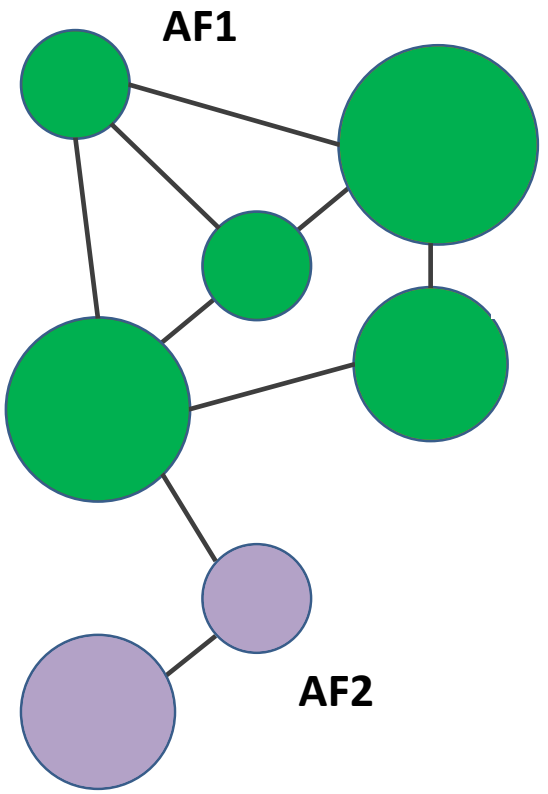
Dj x-$_{y}$= is the part that will buy the sector x to y.

Dij= is the distance by road between the origin municipality *i* and destination municipality *j*.

Beta= is a parameter representing the friction internalizes overcome the space separating municipalities i from j. Corresponds to a value resulting from the analysis of the mobility matrix work-work for the MRB.

Step Two: Delimitation of Functional economic areas from the methodology of the maximum value of interaction (VI)*

From the matrix resulting from the implementation of step 1 of the methodology (spatial interaction model of production in each municipality) the ***maximum interaction value of economical flow between different municipalities*** *is searched. The results are formation of proto-systems (the previous joining-up process culminates when a closed system is achieved)*. The proto-systems are only consolidated if they are *physically continuous.* Likewise, the consolidation requires a *minimum level of 50% self-containment*. If a proto-system does not reach this degree of autonomy, it is aggregated with the proto-system which has a maximum level of interaction and this continues in an iterative form.



*Methodology developed by Roca and Moix (2005) Interaction of the maximum value (VI) in the functional relationship residence / employment

Step Two: Delimitation of Functional economic areas from the methodology of the maximum value of interaction (VI)*

$$Vi_{ij} = \frac{F_{ij}^{\ 2}}{fts_i\ ftr_j} + \frac{F_{ji}^{\ 2}}{fts_j\ ftr_i}$$

Where:

$Vi_{ij=}$ interaction value of economical flows of KIS-HTI sectors with other sectors between the municipalities *i* and *j*;

F_{ij} y $F_{ji=}$ reciprocal economical flows of KIS-HTI sectors with other sectors between municipalities *i* and *j;*

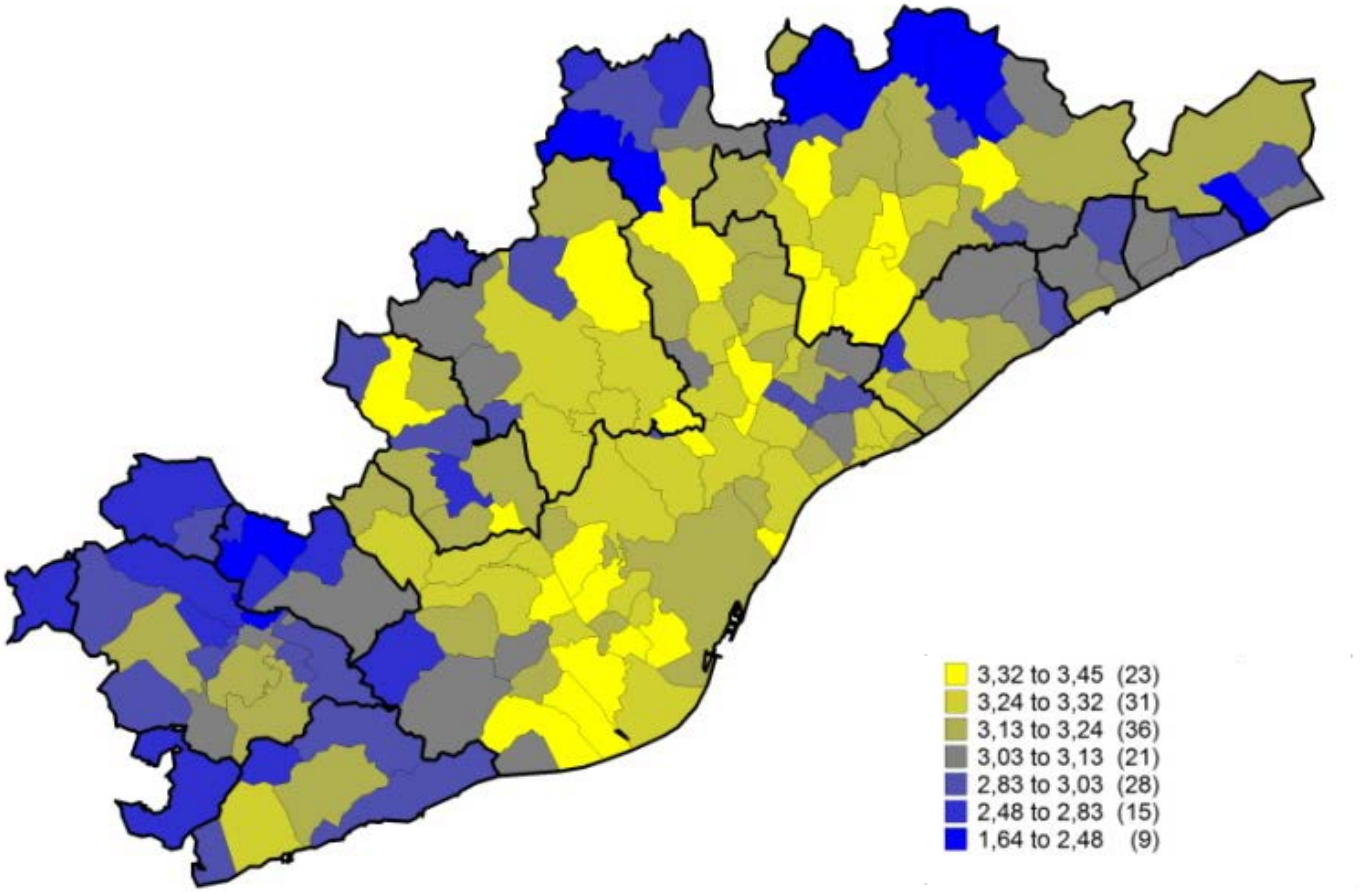
$fts_{i=}$ total flows of KIS-HTI sectors with other sectors from *i* to the rest;

$ftr_{i=}$ total flows of KIS-HTI sectors with other sectors received in *i* from the rest municipalities

*Methodology developed by Roca and Moix (2005) Interaction of the maximum value (VI) in the functional relationship residence / employment

Functional economic areas of KIS and HTI sectors in MRB

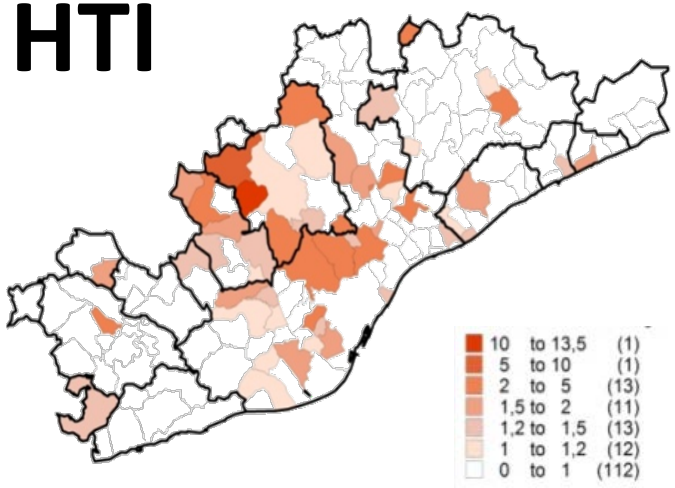
Diversity index of economical activity



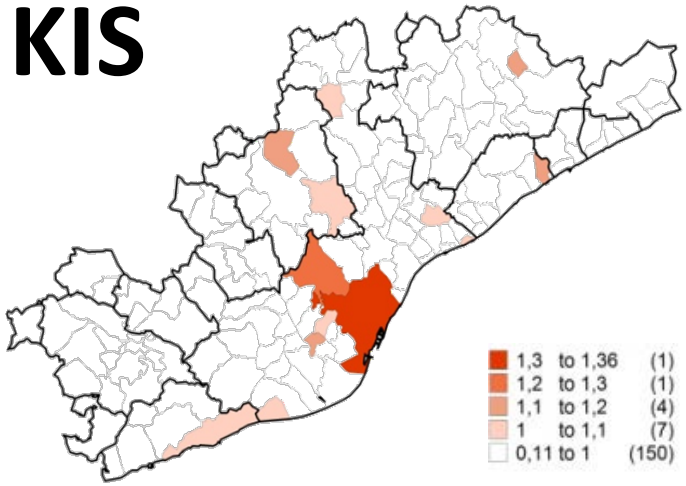
Functional economic areas of KIS and HTI sectors in MRB

Specialization index of economical activity

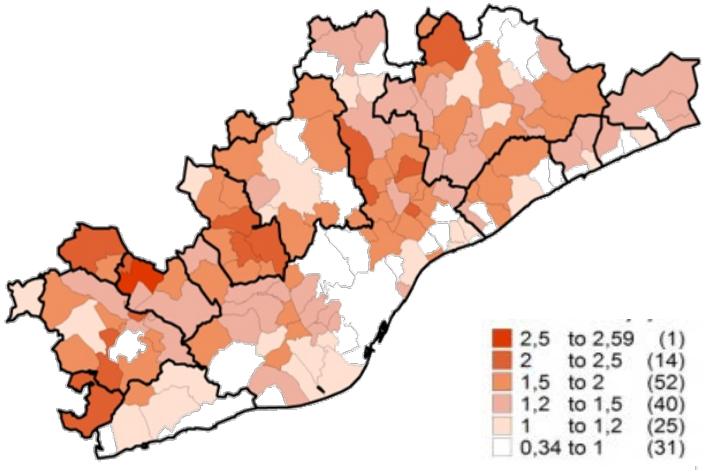
HTI



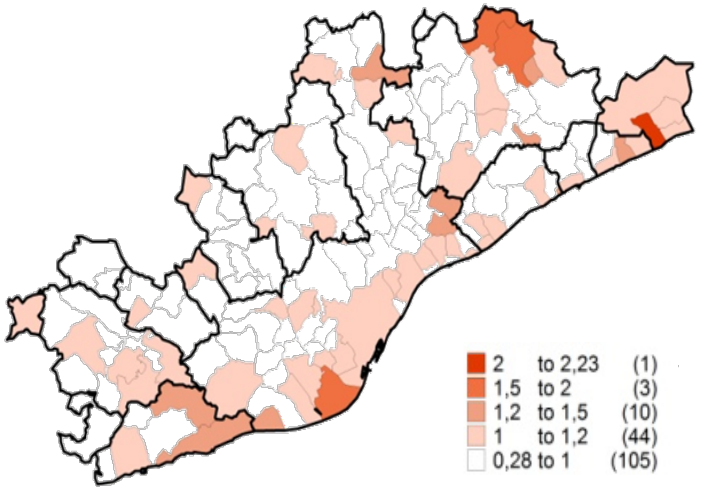
KIS



Other manufacturing



Other services



Final remarks

Final remarks

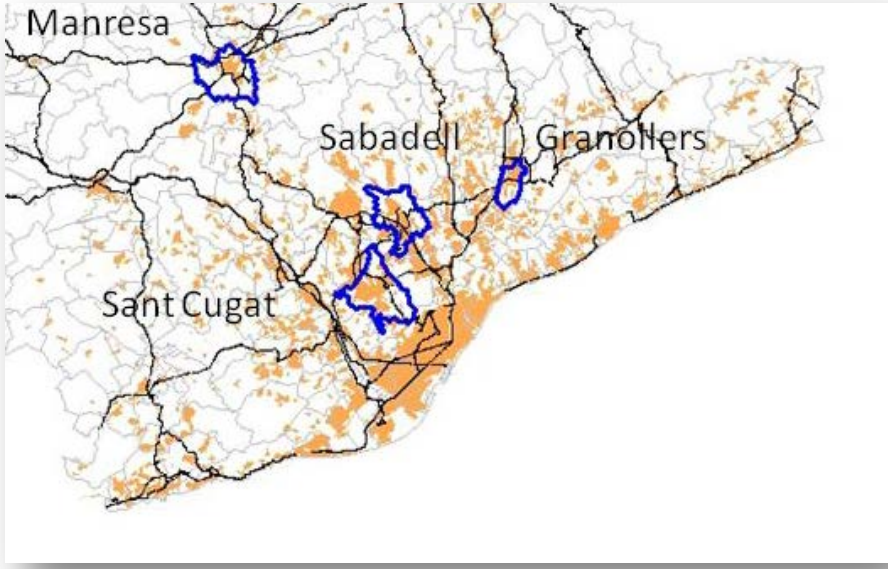
1. The principal characteristic of the Barcelona city region is concentration of economic activity in and around the capital, within the metropolitan region, and the low representation of such activity within the hinterland or remainder of the city region, with the exception of important centres of employment of medium size.
2. The deindustrialization marking the decrease in industrial economic activity and the increase in economic activity in the service sector was very much reflected in the Barcelona city region.

3. From the definition of economic proto-systems, which were a prelude to defining functional economic areas, the results have reflected a metropolitan structure clearly determined by the characteristics of the underlying economic structure, in which is observed around urban centers with larger and diversified labor markets, the most extended and consolidated functional economic areas are found.
   Barcelona certainly has the largest and most extended functional economic area, but across the metropolitan territory there are other areas, which are genuine areas of economic and territorial functionality, alternatives to the area of Barcelona, forming in that sense a real equipotential territorial system of funcionality in the MRB.

According to the interviews of the public authorities in four case studies... What territorial factors have conditioned the phenomena of consolidation of KIS-HTI sectors? *(in 4 employment subcentres)*

Common features of each of the four case studies:

1. Good accessibility and communication,
2. Less congestion,
3. Industrial land prices being lower than in the core of the city region (i.e. in and immediately around Barcelona),
4. Access to a wide and skilled labour market,
5. Availability of industrial land.



In the particular case of Sant Cugat del Vallès:

- ❑ High quality residential areas and low residential density,
- ❑ High proportion of employed population in the business sector.

Thank you

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